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HEMORHEOLOGICAL CHANGES, THE STATE OF
MICROCIRCULATION, AND BLOOD ACID-BASE
BALANCE IN RATS UNDER CONDITIONS OF A
30-DAY LIMITING OF THE MOTOR ACTIVITY

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16. Abstract Changes in the microcirculatory bed were revealed in experiments on rats after a 30-day limiting of motor activity; these were expressed in reduction in number of true capillaries, the appearance of nonfunctioning empty vessels, and in the opening of the arteriolo-venular shunts. Changes in the acid-base balance in the direction of reduction of buffer blood content were also noted.			
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HEMORHEOLOGICAL CHANGES, THE STATE OF MICROCIRCULATION,
AND BLOOD ACID-BASE BALANCE IN RATS UNDER CONDITIONS
OF A 30-DAY LIMITING OF THE MOTOR ACTIVITY

Yu. M. Shtykhno, V.I. Udovichenko*

It is shown that a negative influence is exerted on /68** many organs and systems of the body by limiting the motor activity, including the circulation system (L.I. Kakurin; I.G. Krasnykh; V.V. Parin, et al.; S.M. Peregontsev; Kakurin; I.G. Krasnykh; V.V. Parin, et al.; S.M. Peregontsev,, Chobanion, et al). We studied the influence of long (100 days) hypokinesia on the microcirculation system. We found a great reduction of the nutritive component of the circulation system (Yu.M. Shtykhno and V.I. Udovichenko). In order to clarify the dynamics of these changes, we studied the action of 30-day hypokinesia. We considered the fact that the state of microhemodynamics and its disturbance are closely connected with the most important property of the blood - its fluidity, determined to a great extent by its viscosity. We felt it was advantageous to clarify the dependence of the changes observed on the state of microhemorheology (fluidity of the blood and its viscosity).

Method. The experiments were performed with 26 male rats of the Wistar line weighing 130-140 g. Thirteen of the animals in the experimental group were held for 30 days in small cages which limited their motor activity. Thirteen of the control animals were maintained under normal vivarium conditions for the same period of time. Both the

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control group and the experimental group were fed in the same way, which included 20 grams of briquette feed per one rat per day and as much water as desired.

/69

The microcirculation was observed by a method previously described (Yu.M. Shtykhno and V.I. Udovichenko). The indices of the acid-alkali balance were measured on a AZIV-2 device in tests of three blood-carrying vessels: the carotid artery, the femoral and portal veins. In order to study the rheological properties of the blood, we determined the sedimentation rate of the erythrocytes (ESR) according to the Panchenkov method, the hematocrit index (by centrifuging at a rate of 3000 rpm for 15 minutes), the aggregation index, the suspension stability of the blood (Dintenfass), adhesion of the blood elements formed (Copley), and the dynamic viscosity on a capillary viscosimeter which we perfected (V.I. Udovichenko) in a test on the portal vein. The blood fluidity (yield value) was determined by the graphic construction of the dependence of the shear stress on the displacement velocity.

Results of experiments and discussion. In studying the microcirculation of animals in the experimental group, as compared with the control rats, we detected changes in the structure of the microcirculatory bed. This was expressed in a reduction of the microvessels and true capillaries, the appearance of plasmatic and empty nonfunctioning vessels. We found functioning arteriolo-venular anastomoses which shunted the capillary circulation. However, as compared with long (100 days) hypokinesia, these changes were less apparent (Figure 1).

In studying the rheological properties of the blood, it was found that even a 30-day limitation of the motor

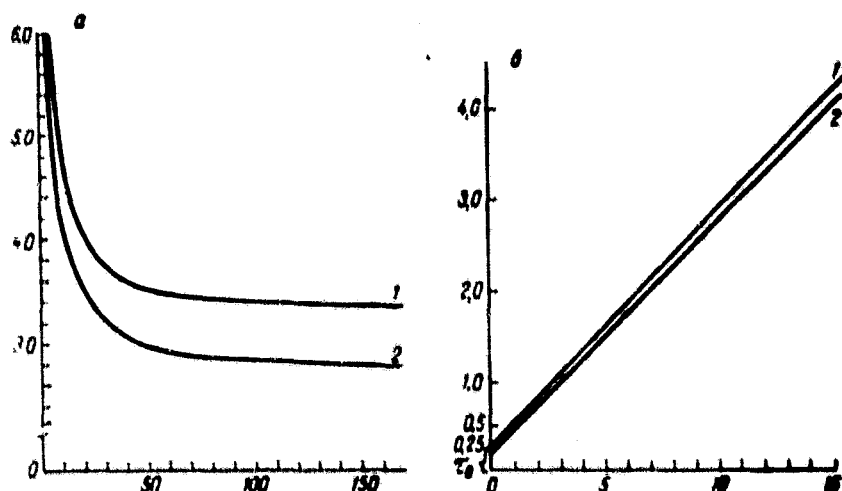


Figure 2. Change in viscosity and fluidity of blood after 30-day hypokinesia. a - curves of dynamic viscosity of the blood at 37.5°C. 1 - experiment; 2 - control. On ordinate axis - viscosity. On abscissa axis - displacement rate (in inverse.s); b - graphic calculation of yield limit (τ_0) according to Casson. 1 - experiment ($\tau_0 = 0.063 \text{ dyn/cm}^2$); 2 - control ($\tau_0 = 0.034 \text{ dyne/cm}^2$). On ordinate axis - shear stress - τ (in dyne/cm^2)^{1/2}. On abscissa axis - displacement rate u (in sec^{-1})^{1/2}.

activity was accompanied by an increase in the dynamic viscosity and reduction of the blood fluidity (Figure 2). The yield limit, i.e., the minimum yield value which must be applied to set the blood in motion, was twice as high in the experimental group as in the control group. A deterioration in the rheological properties of the blood was indicated by a change in the other hemorheological indices (increase of adhesion of blood elements formed, reduction of its suspension stability, increase in ESR and hematocrit index; Figure 3). Just as with long hypokinesia (Yu.M. Shtykhno and V.I. Udovichenko)

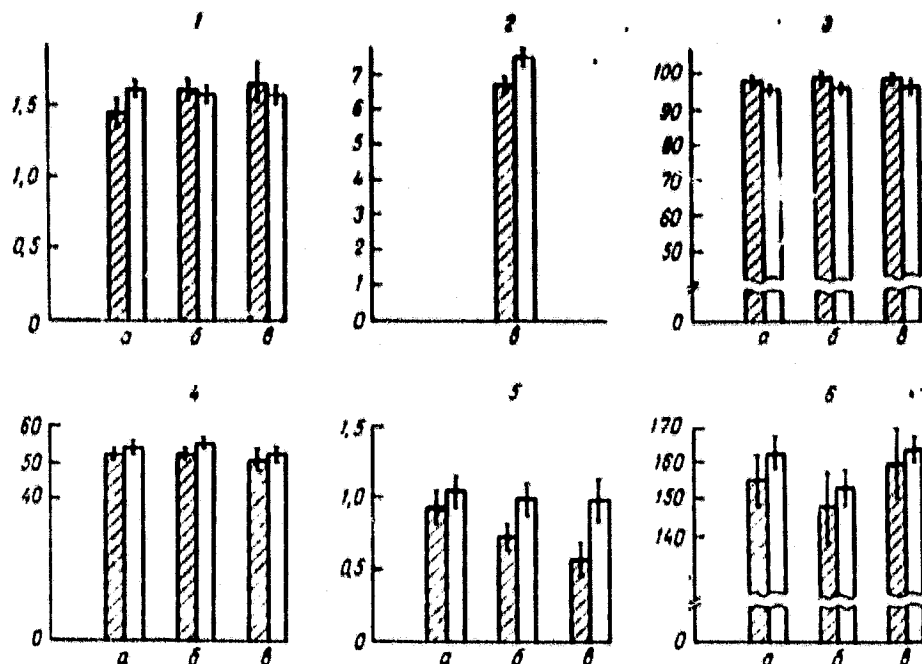


Figure 3. Change in hemorheological indices after 30-day hypokinesia. Here and in Figure 4, the shaded columns are the control; the non-shaded columns are the experiment: a - a. carotis; b - v. femoralis; c - v. portae
 1 - aggregation index (in relative units); 2 - adhesion (in micrometers); 3 - suspension stability of blood (in %); 4 - hematocrit index (in %); 5 - erythrocyte sedimentation rate (in mm/hr); 6 - hemoglobin (in g/l).

we found a decrease in the content of blood buffer bases, indicating the depletion of alkali reserves of the blood due to a deterioration of the perfusion of the tissues and accumulation in them of acidic metabolites (Figure 4).

The data obtained indicate that even a 30-day limitation of motor activity leads to a deterioration of the nutritive blood circulation, which is expressed, on the one hand, in restructuring of the microcirculatory bed

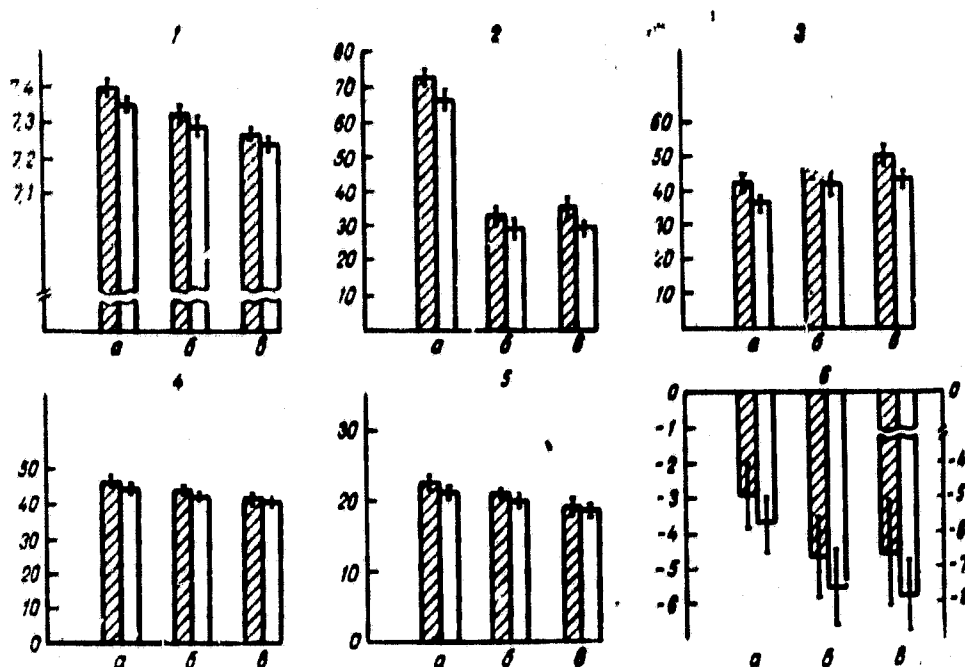


Figure 4. Change in indices of acid-alkali balance of the blood after 30-day hypokinesia.

1 - pH (in units); 2 and 3 - tension of O_2 and CO_2 in blood, respectively (in mm, Hg); 4 - buffer bases (in meqv/l); 5 - standard bicarbonate (in meqv/l); 6 - displacement of buffer bases (in meqv/l).

Remaining notation, same as Figure 3

(decrease in amount of functioning capillaries and appearance of functioning arteriolo-venular anastomoses), and on the other hand, a deterioration of the rheological properties of the blood (increase of viscosity, reduction of fluidity), and due to this a reduction of the circulation rate. All of this leads to a deterioration of nourishment of the tissues, which is expressed in a change in the indices of the acid-alkali balance of the blood in animals during hypokinesia.

REFERENCES

- Kakurin, L.I. In the book "Fiziologicheskiye problemy detrenirovannosti (Physiological problems of de-training). Moscow, 1968, pp 34-43.
- Kovalenko, Ye.A. Kosmicheskaya Biol., 1976, No. 1, pp 3-15.
- Krasnykh, I.G. Voen. Med. Zh., 1973, No. 12, pp 54-56.
- Parin, V.V., Krupina, T.N., Mikhaylovskiy, G.P., et al. Kosmicheskaya biol., 1970, No. 5, pp 59-64.
- Peregontsev, S.M. Voen. Med. Zh., 1972, No. 11, pp 63-64.
- Udovichenko, V.I. Pat. Fiziol., 1977, No. 6, pp 56-58.
- Shtykhno, Yu.M., Udovichenko, V.I. Byull. eksper. biol., 1977, No. 4, pp 403-405.
- Chobanian, A., Lille, R., Terega, A., et al. Circulation, 1974, v. 49, pp 551-559.
- Copley, A.L. Scott-Blair, T.W., Glover, F.A. et al. Kolloid-Z., 1960, Vol. 168, pp 101-107.
- Dintenfass, L. Circulat. Res., 1962, v. 11, p 233-239.

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